

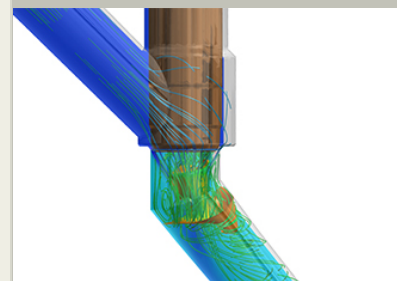
Robust Cryogenic Cavitation Modeling for Propulsion Systems Ground Test Facilities, Phase II

Completed Technology Project (2017 - 2019)



Project Introduction

Rigorous ground testing mitigates space propulsion system risk by enabling advanced component and system level rocket propulsion development and by demonstrating that designs reliably meet the specified requirements over the operational envelope before the first flight. The development of advanced ground test technology components and systems that are capable of enhancing environment simulation, minimizing program test time, cost and risk and meeting environmental and safety regulations is focused on near-term products that augment existing state-of-the-art propulsion system test facilities. Thus improved capabilities to model and predict component behavior in harsh ground test environments are needed for enhanced facility design. In particular, components such as pumps, turbines, valves and chokes may experience vibration and damage due to cavitation in the flowing liquid, and any reduction in the severity of the operating conditions would provide expanded test and performance benefits. The proposed innovation is to develop an unsteady cavitation model based on a tabular equation of state and a representation of cavitation bubble dynamics that together describe the growth and collapse of nucleated bubbles in a liquid cryogen. Important nonequilibrium mechanical and thermal effects will be considered by using a drift-flux model and adding an additional energy equation for the liquid temperature. Validation of the advanced cavitation models will be accomplished for both steady and unsteady flows by comparing surface pressure and temperature data and computing power spectra from frequency domain analyses. The final analysis tool will be used to demonstrate the significant nonequilibrium flow behavior for both the validation cases and actual production analysis problems of interest to NASA.

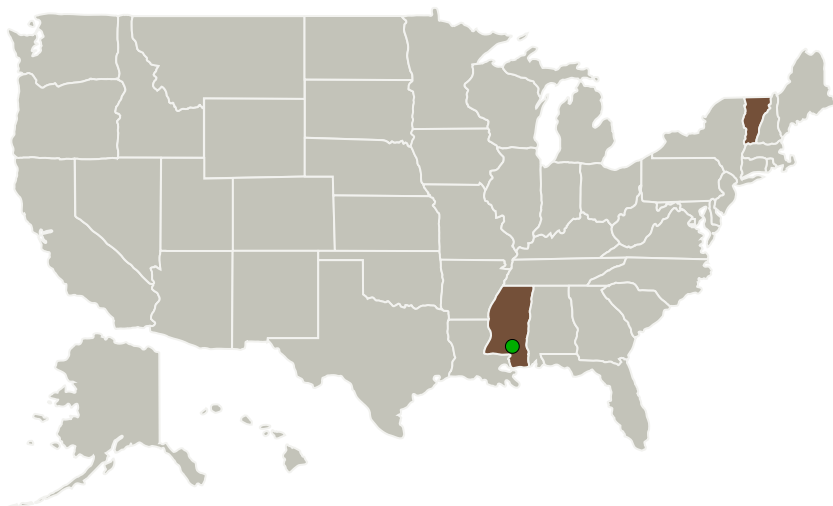


Robust Cryogenic Cavitation
Modeling for Propulsion Systems
Ground Test Facilities, Phase II

Table of Contents

Project Introduction	1
Primary U.S. Work Locations and Key Partners	1
Project Transitions	2
Images	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Technology Areas	3
Target Destinations	3

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
Tetra Research Corporation	Lead Organization	Industry Women-Owned Small Business (WOSB)	Princeton, Illinois
● Stennis Space Center(SSC)	Supporting Organization	NASA Center	Stennis Space Center, Mississippi

Primary U.S. Work Locations

Mississippi

Vermont

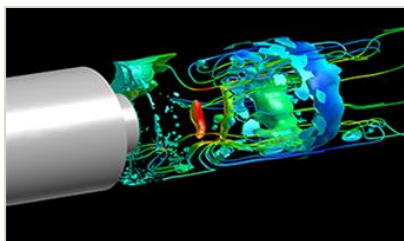
Project Transitions

**April 2017:** Project Start**April 2019:** Closed out

Closeout Documentation:

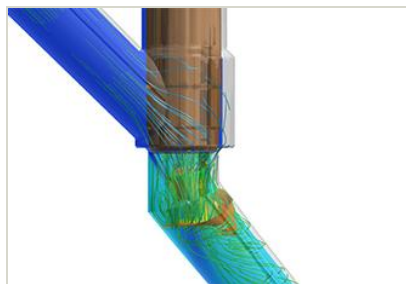
- Final Summary Chart(<https://techport.nasa.gov/file/140987>)

Images



Briefing Chart Image

Robust Cryogenic Cavitation
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Briefing Chart Image
(<https://techport.nasa.gov/image/126131>)



Final Summary Chart Image

Robust Cryogenic Cavitation
Modeling for Propulsion Systems
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(<https://techport.nasa.gov/image/135773>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission
Directorate (STMD)

Lead Organization:

Tetra Research Corporation

Responsible Program:

Small Business Innovation
Research/Small Business Tech
Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

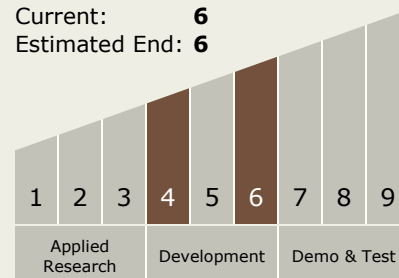
Carlos Torrez

Principal Investigator:

Robert R Chamberlain

Technology Maturity (TRL)

Start: 4
Current: 6
Estimated End: 6



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Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
 - └ TX11.2 Modeling
 - └ TX11.2.4 Science Modeling

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System